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The relevance of the building system boundary to conduct an LCA of a passive house.

A comparison of two frameworks for assessing building sustainable performance: DGNB and Level(s)

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Introduction

LCA in the Building Sustainability Assessmnet Frameworks

Volunteer Certification of the Building Sustainability

Based on main topics:

- Environmental quality assessment (LCA)
- Economic quality (LCC)
- Sociocultural and funtional quality
- Technical quality
- Process quality
- Site quality

Volunteer framework for assessing the Building Sustainability

Based on assessing:

- Environmental performance (LCA)
- Health and comfort
- Life cycle cost and value
- Potential risks to future performance

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	Level(s)	**DGNB System**
LCA Type	Level 1: **conceptual design** Level 2: **detailed design and construction** Level 3: **as-built and in-use**	**Partial calculation method**: very simple recording of the constituent parts of the building **Simplified calculation method**: main components from the building component catalogue **Complete calculation method**: all constituent parts and their associated processes
Reference study period	50 years	50 years
Reference standards	– **EN 15978**: Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method – **EN 15804**: Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products	– **EN 15978**: Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method – **EN 15804**: Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products

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Level(s)																	
Cradle-to-Grave	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Product stage, calculated energy performance and projected service life (SR OP1)	X	X	X						X	X	X						
Product stage, calculated energy performance and building material bank (SR OP2)	X	X	X								X				X	X	X
DGNB System																	
Declared modules (Building Elements depend on the type of LCA).	X	X	X				(X)		(X)		(X)				(X)	(X)	(X)

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Scope — Life cycle stages

Cradle-to-Grave **(A1-A5; B1-B7; C1-C4; D)**
*Reporting options:
- Product stage, calculated energy performance and projected service life: **A1-A3**, **B4-B6**
- Product stage, calculated energy performance and building material bank: **A1-A3**, **B6**, **C3-C4**, **D**

- Product stage: **A1-A3**
- Use stage: **B2**
- Maintenance: **B4** (only production and disposal of replaced product)
- Operational energy use: **B6**
- End of Life: **C3-C4**
- Benefits and loads beyond system boundary: **D**

Scope — Building elements

Shell:
- Foundations
- Load bearing structural frame
- Non-load bearing elements
- Facades
- Roof
- Parking facilities
Core:
- Fittings and furnishings
- In-built lighting system
- Energy, ventilation, sanitary systems
- Lifts, escalators, communication and security installations, telecoms and data installations
External works

The entire building, **without** external installations.

For evaluations that only consider specific parts of a structure, the system limits of the LCA must be clearly defined.

Depends on chosen calculation method

Partial calculation method
Simplified calculation method
Complete calculation model

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	Level(s)	DGNB System
Data requirements	Data should be in compliance with quality requirements of EN 15804	Data should be in compliance with quality requirements of EN 15804 and ISO 14025
Data selection	– **Specific** data derived from **specific** production processes, e.g. Environmental Product Declarations (EPDs) of a product that specified to be used in the construction and calculated using specific data for at least the processes the producer of the specific product has influence over. – **Average** data derived from specific production processes, e.g. EPDs of average products and calculated using representative average data;	– **Specific** and <u>**verified**</u> LCA data (e.g. EPD) should be preferred over general, generic LCA data. – The use of manufacturer-specific data sets for products that are <u>**not**</u> used in the building is only permitted in justified exceptional cases and only if a safety margin of **at least 10%** is added to the DGNB LCA indicator results to consider possible deviations.

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Introduction – LCA: Level(s) vs DGNB

Level(s)
European framework for sustainable buildings
#BuildCircular
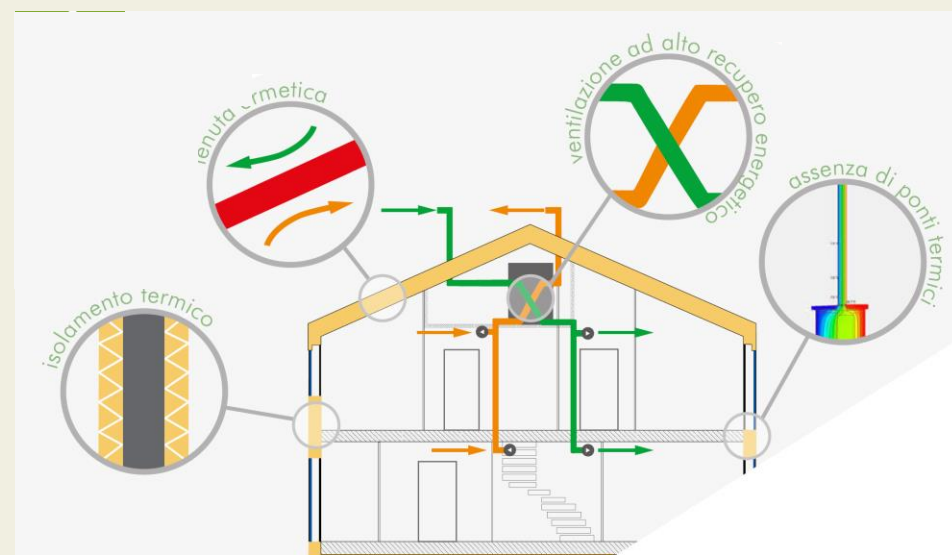
DGNB System

Impact categories

Level(s)

1. Climate change (total, fossil, biogenic, land use and land use change)

2. Ozone depletion

3. Acidification

4. **Eutrophication aquatic (freshwater and marine)**

5. **Eutrophication terrestrial**

6. Photochemical ozone formation

7. Depletion of abiotic resources – minerals and metals

8. **Depletion of abiotic resources – fossil fuels**

9. Water use

DGNB

1. Climate change (total)

2. Ozone depletion

3. Acidification

4. **Eutrophication (total)**

5. Photochemical ozone formation

6. **Non-renewable primary energy demand**

7. Depletion of abiotic resources – minerals and metals

8. **Total primary energy demand**

9. **Proportion of renewable energy demand**

10. Water use

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Methods

Ilustrate the differences between both frameworks (Level(s) vs DGNB) using an Italian passive house "Casaunica" as a case study
located in Biellla (Italy), climate zone E

A+ (<15 kWh/m² year)

Source: http://www.casaunica.it/

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LCA framework and impacts calculation

Building elements included

Scope — Building elements

Which building element to include?
The Shell, including:
- Non-load bearing elements
- Load bearing structural frame
- Facades
- Roof

List of building components, includes all the materials and elements of the:

- **Roof**
- **Facades**
  - Vertical External walls
  - Vertical External windows
- **Non-load bearing elements**
  - Slab-on-grade

Which building element to include?
The entire building, **<u>without</u>** external installations.
Depends on chosen calculation method

PCM included (A1-A3):
- Roof (only perimeter insulation and concrete or main material)
- External walls (only concrete)
- Slab-on-grade (only concrete)

SCM included (A1-A3):
- Roof
- External walls (including windows and doors)
- Slab-on-grade

CCM included (A1-A3, B2;B4, B6; C1-C4; D):
- Material cutt-off rules

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LCA framework and impacts calculation

Life Cycle Stages included

	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Level(s) (European framework for sustainable buildings)																	
Product stage, calculated energy performance and projected service life (SR OP1)	X	X	X						X	X	X						
Product stage, calculated energy performance and building material bank (SR OP2)	X	X	X								X				(X)	(X)	(X)
DGNB System																	
Declared modules (depending on the building element).	X	X	X				(X)		(X)		(X)				(X)	(X)	(X)

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Influence on the LCA results

	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D	Total
Level(s)																		
Product stage, calculated energy performance and projected service life	X	X	X						X	X	X							
GWP (SR OP1) (kgCO2eq./m2*yr)		308,41							77,48	0	30,55							416,45
Product stage, calculated energy performance and building material bank	X	X	X						X						(X)	(X)	(X)	
GWP (SR OP2) (kgCO2eq./m2*yr)		308,41									30,55				48,93	2,40	-89,59	300.71
DGNB System																		
Declared modules (depending on the building element).	X	X	X				(X)		(X)		(X)				(X)	(X)	(X)	
GWP (PCM) (kg CO2eq./m2*yr)		159,65					0*		0**		30,55				24,96	0***	-2,58	212,59
GWP (SCM and CCM) (kgCO2eq./m2*yr)		308,41					0,005		77,48		30,55				48,93	2,40	-89,59	378,21

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Conclusions

Regarding the Building Sustainability Assessment Frameworks,

- **when conducting LCA system boundaries are mostly affected by data availability. For example, EPDs or ÖKOBAUDAT, include limited data about the building products /material life cycle stages.**

- **need for harmonizing the LCA application which affects the carbon metrics (especially needed for decarbonization path) and other environmental impacts calculation.**

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Conclusions

The harmonization needs to address:

- **LCA stages and information modules**
- **Building systems, elements and components**
- **LCA application along the building design stages**
- **Environmental Impact categories and indicators**
- **Service life, maintenance and replacement**

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